DOCUMENT RESUME

ED 265 064 SE 046 365

TITLE Sea Turtles: An Auditorium Program, Grades 6-9.
INSTITUTION National Aquarium in Baltimore, MD. Dept. of Education.
PUB DATE 85
NOTE 30p.; For related documents, see SE 046 364-367.
AVAILABLE FROM National Aquarium in Baltimore, Pier 3, 501 East Pratt St., Baltimore, MD 21202 ($2.00).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Animal Behavior; *Animals; Elementary School Science; Field Trips; Intermediate Grades; Junior High Schools; *Marine Biology; *Marine Education; *Science Activities; Science Education; *Secondary School Science; *Wildlife; Wildlife Management
IDENTIFIERS *Sea Turtles

ABSTRACT

The National Aquarium in Baltimore's sea turtle auditorium program introduces students in grades 6-9 to the seven (or eight, depending on which expert is consulted) species of sea turtles alive today. The program, which includes slides, films, artifacts, and discussion, focuses on sea turtle biology and conservation. This booklet covers most of the content of the program and offers a variety of activities for the different grade levels. It includes: (1) suggestions for activities before, during, and after the visit; (2) background information on sea turtles, including descriptions of these species: leatherback ("Dermochelys coriacea"); flatback ("Chelonia depressa"); green ("Chelonia mydas"); hawksbill ("Eretmochelys imbricata"); olive ridley ("Lepidochelys olivacea"); Kemp's ridley ("Lepidochelys kempi"); and loggerhead "Caretta caretta"); (3) worksheet for sea turtle observations and vocabulary word search; (4) loggerhead life cycle game (with instructional strategies); and (5) lists of books and magazines about sea turtles. (JN)

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SEA TURTLES

AN AUDITORIUM PROGRAM
GRADES 6–9

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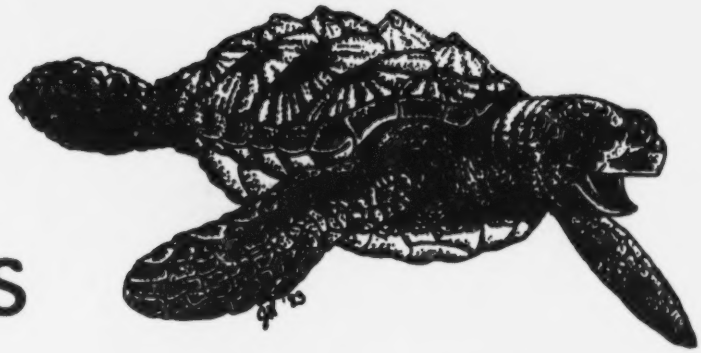

SEA TURTLES

The Sea Turtle auditorium program will introduce your students to the seven (or eight depending on which expert you consult) species of sea turtles alive today. The program will include slides, film, artifacts and discussion. Your students will learn about sea turtle biology and conservation. This booklet covers most of the content of the program and offers a variety of activities for different grade levels. Here are some suggestions for enhancing the impact of the sea turtle program.

BEFORE YOUR VISIT

1. Hang a large map of the world in your classroom. Ask each student to find one magazine or newspaper article about sea turtles and bring it to class or write a report about it. This is a chance to learn to use the Readers Guide to Periodical Literature at the library. Have each student find the location of the sea turtles in his/her article on the map. They might make a brief report to the class as well.

2. The enclosed map of the nesting sites of the loggerhead sea turtle is a take-off point for geography and social sciences as well as turtle conservation. Have individual students or groups compare the nest site map with a map of the world that shows all the nations. Have them list all of the countries where sea turtles nest. They are:

United States (to Virginia)	Jamaica	Cyprus
Bahamas	Cuba	Egypt
Mexico	Brazil	Mozambique
Guatemala	Morocco	Madagascar
Nicaragua	Senegal	Oman
Costa Rica	Nambia	Burma
Panama	South Africa	China
Columbia	Turkey	Taiwan
Venezuela	Syria	Japan
Puerto Rico	Lebanon	Australia
Dominican Republic	Israel	

Ask your students if they think it might be hard to get agreements on sea turtle conservation signed by all of these countries? Why? Can they think of some pairs of nations that may not get along too well? Why? Possible countries for discussion:

United States and Cuba	China and Taiwan
United States and Viet Nam	Syria, Lebanon and Israel
Nambia and South Africa	Nicaragua and Guatemala

Sea turtles are citizens of the world and not just one country. In order to protect them, we need to learn to work together.

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3. How big does a sea turtle get? Try some math activities. Draw a circle the size of a hatchling's shell on the board: 4-5.5 cm. Now draw the size of the adult(see enclosed pages on individual species) or use the loggerhead which gets to 110 cm. How much bigger is this? 24 times! Compare with how much people grow in height. Even more impressive is the weight gain. From about 100 gm at hatching to 105 kg. at adulthood. This is more than a thousand fold increase. How much would people weigh if they grew to 1000 times their birth weight?

4. Review the characteristics of reptiles in general. They breathe air with lungs (snakes have only one lung!); have waterproof skin with scales made of the protein,keratin; lay eggs with tough, leathery shells; and leave the eggs in nests to develop on their own. They are vertebrates - they have a backbone. It is fused to the bones in their upper shell or carapace. Can you name some reptiles other than turtles? Lizards, snakes, alligators, crocodiles, and dinosaurs.

   Reptiles are commonly called coldblooded. Actually, they are the temperature of their environment and may get quite warm sitting in the sun. Animals with temperatures determined by outside sources are called ectotherms. (Ecto = external; therm = heat.) Most reptiles are ectotherms. They may sometimes be able to regulate their body temperature with behavior, moving into or out of the sun.

   Recently, scientists have discovered that some reptiles have temperatures above that of their environment. The largest of the sea turtles, the leatherback, produces heat as a waste product of its muscles as it swims. Because of its size, the core of its body may get quite warm. New evidence about the structure of dinosaur bones indicates that they may have been warmblooded, able to regulate their body temperature. The proper name for animals that produce their own heat is endotherm. (Endo = internal.)

DURING YOUR VISIT

1. Following the auditorium program, your students may do one or both of the enclosed sea turtle worksheets as they tour the building with their chaperones. Please have clipboards and pens or pencils that are firmly tied to the board.

   a. The first worksheet goes with the sea turtle skeleton hanging in the central space above the open marine mammal pool. It can best be viewed from level 3.
   b. The second sheet is a study of the hawksbill sea turtle that lives in the Atlantic Coral Reef, the first of the two giant ring tanks. The turtle moves around and may be hard to find. If there is an exhibit guide in the coral reef, ask her/him to help you find the turtle.

   Answers appear at the end of this booklet.

FOLLOWING YOUR VISIT

1. Check your students sea turtle vocabulary skills with the enclosed worksheet, Sea Turtle Vocabulary. The answers are:
   1. carapace
   2. scutes
   3. beak
   4. warmblooded
   5. eggs
   6. nest
   7. flippers
   8. lost year
   9. migration

   The most important word is endangered.

2. Use the Loggerhead Life Cycle game. For younger students it may simply serve as an example of how difficult the life of a sea turtle is. For older students, the enclosed data sheet allows plotting a graph of the loggerhead's survivorship curve.

3. Want more information? The Center for Environmental Education offers a variety of sea turtle materials:

teacher information packet.	$2.50 plus	.85 handling
Sea Turtle Poster	4.00 plus	1.50 handling
Sea turtle Coloring Book(bilingual - Spanish). .	3.95 plus	.75 handling

   Order from: Center for Environmental Education
   Sea Turtle Rescue Fund
   624 9th St., N.W.
   Washington, D.C. 20001

SEA TURTLES

Their ancient sea turtle relatives swam in the seas when dinosaurs still ruled the land. They have successfully followed their marine life style for millions of years - nesting on coastal and island beaches and feeding offshore in the ocean. Sea turtles were sufficiently abundant to serve as a major food supply for the European mariners exploring the world in the 16th and 17th centuries. Humans living along tropical coastlines have eaten turtle eggs and meat for centuries. Yet seemingly almost overnight, six of the seven species of sea turtles face extinction. Why?

The reasons all have to do with humans. The world's population growth rates have increased dramatically in this century. The greatest growth has occurred in the poorer nations of the tropics. Turtle meat and eggs have increasingly served as sources of protein as other resources are exhausted by exploding populations. Turtle products like leather made from skin and jewelry carved from certain species' shells are exported as luxury items for more wealthy nations. Increasing human populations have also forced people to exploit the seas for food. In the process, thousands of turtles die accidentally each year in trawl nets or gill nets intended to catch fish or shrimp. They are also killed in marine dredges and by large boat propellers. In places where turtles once nested in safety, humans have introduced animals that prey on eggs or hatchling turtles. Dogs, pigs and rats all threaten turtle nests. Many of the beaches used for centuries by nesting turtles are now prime recreational spots, lined with hotels, driven on by surf fishermen and dune buggies and continuously populated by people who interrupt nesting. The lights of human habitations fool hatchling turtles into heading away from the sea to a death from dehydration and exhaustion. One species, the leatherback, appears to be dying in increasing numbers from eating plastic bags from the garbage of ships. They evidently mistake them for the jellyfish on which they normally feed. In short, sea turtles are now threatened with extinction.

There are scientists and conservationists who are trying to help sea turtles survive. Many countries including the United States have laws to protect them. But before we can help we need to know more about their biology, and we must educate people.

What are sea turtles?

There are seven species of sea turtles alive today: the leatherback, loggerhead, hawksbill, green, Kemp's ridley, olive ridley and flatback. While some have localized distribution (flatback and Kemp's ridley) most occur in both the Atlantic and Pacific Oceans. While they are more common in the tropics, several species stray seasonally into temperate waters. Because of a reproductive pattern that probably involves turtles returning to nest at the beaches where they were born, different populations within a species are relatively reproductively isolated. Consequently, turtles of one species may vary from

population to population and ocean to ocean. In some cases scientists even argue about how many species there are because of this variability.

Certain aspects of sea turtle biology are reasonably well understood while other areas are a total mystery. Not surprisingly, we know the most about nesting because the turtles are concentrated in one place, during one season at specific locations on land where we can easily observe them. We know very little about what happens during the majority of their lives when they live dispersed at sea. Much of what we know about them comes from chance events such as turtles caught in fishing traps or nets or turtles that wash ashore dead.

Sea turtles have been in the seas for more than 150 million years. One fossil turtle measured three meters in length! Like land-based and freshwater turtles, they have heavy, bony jaws covered with a horny material, the protein keratin. The jaws form a beak with sharp edges and are effective in biting things. They have no teeth. Very hard bone in the interior of the jaw margin enables some species to crush hard shelled invertebrates. Sea turtle species range from vegetarians to carnivores to generalists that eat almost anything. Many switch from one diet as juveniles to a new diet as they mature.

Sea turtles feed under water or at the surface. If not feeding, they generally remain at the surface. When actively feeding, sea turtles come to the surface for air every few minutes. If resting or sleeping, they use less oxygen and breathe much less frequently. Hawksbills sleep by wedging themselves into a crack in a coral reef, sleeping under water. They can easily stay down for several hours. Loggerheads may also rest on the bottom for extended periods.

In addition to oxygen gained by breathing air, sea turtles can also obtain a little oxygen directly from sea water. The cloaca, a sac into which both the excretory and reproductive systems open, can be used for gas exchange with the sea water. Oxygen diffuses in and carbon dioxide out. While this does not provide much oxygen, it is enough to sustain loggerheads that hibernate under water in the mud during very cold weather.

The sea turtle has a streamlined body which provides little resistance as it passes through water. Most of the propulsion is provided by the long, powerful front flippers while the rear flippers act as paddles for steering. Flippers are exceptionally well designed for life in the sea, but are very awkward on land. Sea turtles cannot walk or support themselves, but rather must drag themselves across the beach. The rear flippers also help in nest building. The broad, paddle-like hind flippers make excellent sand shovels. Most species have one or two claws on their flippers although the leatherback has none. The claws help gain purchase on hard surfaces.

While the leatherback lacks a hard shell, the other species of sea turtles have a hard shell of bony plates both above and below. The spine and pelvic and pectoral bones are fused to the upper shell called the carapace. The lower shell or plastron is flexible at the joint with the upper shell, allowing it to move

during breathing. Unlike land turtles, sea turtles cannot withdraw into their shell. The front flippers partially fit into a groove on the plastron for improved streamlining. The shell is covered with thick, horny plates called scutes which are smooth and colored. The scutes are made of the same protein, keratin, as the beak. The leatherback lacks scutes and has a mixture of small bones and cartilage in its "shell."

Sea turtles start life as small round eggs with flexible, leathery shells. Depending on the species, they range in size from about 4 to 5.5 cm (1.5 - 2 in.). They are laid in a hole dug in the sand on a beach above the reach of the waves, but where the sand is a little moist to keep the developing eggs from drying out. Some eggs are also laid which are infertile and appear to help maintain the correct nest moisture as they dehydrate very slowly. The temperature at which the eggs incubate determines the sex of the hatchlings. Cool nests (less than 28°C) produce males. Warm ones (over 29.5°C) produce females. Nests laid in late spring and early fall produce more males, while summer nests are mostly females.

After 50-65 days, depending on species and nest temperature, the baby turtles break the shell with an "egg tooth" and gradually work their way out of the shell. They rest for several days and then wait for the cool temperatures of night or a rain storm. A frenzied wriggling mass of hatchlings emerge from the sand and head for the brightest horizon, the sea on an undisturbed beach. They thrash along with wildly flailing flippers, awkward on land and highly vulnerable to predation especially by ghost crabs. They cannot cross vertical barriers of even a few inches.

Once they reach the water's edge, they are in their own medium. The hatchlings are graceful and float easily, but are still a tempting mouthful for a predator. No one is absolutely sure where the hatchlings go. Their early life stage is referred to as the "lost year." They are thought to drift with the currents, ending up in the lines of floating seaweed that gather where currents converge. These "drift lines" of algae (seaweed) are places where food collects, and the hatchlings may hide in the seaweed. Predators also collect here, and surface pollution like oil and tar may also concentrate in drift lines. Along the Caribbean and Southeast United States these drift lines of seaweed concentrate in the Sargasso Sea, named for Sargassum, the major group of algae found there. Of the many eggs laid, very, very few turtles survive to reach a size large enough to swim away from the drift lines, leaving their "lost year" behind.

The immature turtles swim away to feeding grounds. They may still be eaten by a large shark, but they are much safer now. They feed and grow for many years. The rate of growth depends primarily on the amount and quality of food that the turtles find. In captivity a green turtle might reach adulthood in 8-10 years with an unlimited food supply. In the wild, 30-60 years is more likely. We know very little about the life of turtles during this time.

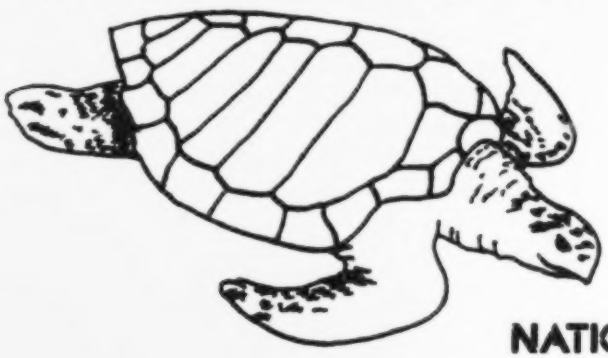
With the onset of sexual maturity, turtles return to the beaches where they were hatched. For some populations this means a very long journey. One population of green turtles swims from feeding grounds on the coast of Brazil some 4,800 km (3,000 miles) to Ascension Island off the coast of Africa. Theories about how they navigate long distances range from magnetic fields to sense of smell to celestial navigation. The discovery of tiny particles of magnetite, which is used in compass needles, in turtles may give a clue. They may well have a built in compass.

In the water near their home beach, the sea turtles mate. They may remain near the beach for some time before nesting. Nesting generally occurs during summer with most of the eggs laid during the warmest months, and fewer in late spring and early fall.

In the two species of ridleys, nesting is a mass event. In other species nesting is more solitary. With the exception of the Kemp's ridley, they come ashore at night. Females may nest more than once during the summer. One loggerhead was observed nesting six times in one season in Florida. They do not nest every year, but rather every second or third year. The large number of eggs laid requires a great amount of stored energy.

The female drags herself on shore and up the beach beyond the reach of the highest waves. She digs a pit with her front flippers and then an egg chamber with her hind flippers. It may be four to five feet below the surrounding sand. During the process of picking a nesting site, the female may retreat to the sea if disturbed. Once she starts laying, she finishes regardless. A person may sit behind the turtle and count the eggs as they fall. Depending on the species and the point in the nesting season, a turtle may lay 30-200 eggs. They are covered with sand before she retreats to the sea. A distinctive track marks her progress. The track and the depression clearly mark the nest site.

Under natural conditions sea turtles may die for many reasons. Raccoons and other natural predators dig up the eggs and eat them. Storms may wash away the nests before the eggs hatch. When turtles were very abundant, they also accidentally dug up other nests when making their own. The hatchlings are eaten by a variety of night time predators, particularly the large white burrowing ghost crabs. Hatchlings may also be taken by sea birds. In the water, sharks and other fish prey upon sea turtles until they reach a large size. Even the largest can have a flipper bitten off by a shark. Scientists estimate that only one turtle in a thousand lives to reproduce, but one turtle may lay many eggs in a lifetime. But until recently under natural conditions sea turtles nested by the thousands and survived millions of years while thousands of other species went extinct. Now sea turtles face extinction themselves.



In the United States the Endangered Species Act makes it illegal to have or import sea turtles or any part of a sea turtle including meat, eggs, cosmetics containing the oil, "tortoiseshell" jewelry, turtle leather products, or stuffed sea turtle souvenirs. Even picking up a dead turtle on the beach is illegal. The Aquarium has a federal permit to display sea turtles for educational purposes and also has permits for seized sea turtle materials donated by the U.S. Fish and Wildlife Service for educational use.

Despite the Endangered Species Act, sea turtles are not entirely safe in the United States. A great deal of the damage done to turtle nesting sites unintentionally is just as devastating as outright slaughter, but not as obvious. Worldwide, beaches are disappearing under tourist hotels and vacation homes. In the United States, an enormous expansion in coastal development has resulted in resort complexes and vacation homes covering the beaches of the Southeastern U.S. Nest sites are lost or seriously disturbed. Additionally, hatchling turtles are disoriented by the lights from homes and motels and head in the wrong direction when they leave the nests. People along the southeast coasts of the U.S. are now being asked to turn off all their lights at night during the summer to help.

Several states carry on active sea turtle education programs to help protect nesting sites in highly populated areas. One hotel in Boca Raton, Florida was forced to hire a sea turtle biologist before they could build near a nest site on the shore. The biologist protects nests, and she does turtle beach walks for hotel guests.

There are national seashores and state parks which are still undeveloped, but allow recreational vehicles access to the beach. They crush nests and their tire tracks trap the hatchlings as they head for the ocean. The only places left where sea turtles may nest in peace in the U.S. are uninhabited barrier islands with no public access.

One area of progress is in the design of the shrimp trawls which accidentally kill sea turtles. The National Marine Fisheries Service of the U.S. government has funded the development of a trawl with a "turtle exclusion device" (TED) which keeps the turtles out. After trials proved that the new net design also caught 7% more shrimp, the NMFS people changed the name to "trawl efficiency device." It is now being marketed world-wide.

Another area in which progress is being made is in the U.S. Virgin Islands where a variety of programs combining government wildlife officers and groups like Earthwatch are working together to prevent egg poaching by guarding beaches during the nesting season and hiding nests more effectively than the turtles do.

Scientists and government agencies in the United States are cooperating in programs that transplant eggs to new, safe beaches in the hope of establishing new populations (Kemp's ridley) or reestablishing old turtle populations (loggerhead). They are also participating in a worldwide effort by scientists to collect sea turtle information and promote sea turtle conservation.

Internationally, scientists in many countries are working to educate their own governments and people about sea turtle conservation. Some countries have responded very well. Costa Rica has made several important turtle nesting beaches into protected national parks. Indian ecologists are working to reduce the commercial sale of turtle meat and eggs.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was held in 1973. The agreements reached to protect endangered (threatened with extinction) and threatened (may become endangered) species have been signed now by 67 countries. Appendix I (endangered) species are prohibited from commercial trade while threatened (Appendix II) species are restricted in trade under the agreements. Leatherbacks, greens, loggerheads, Kemp's ridley and hawksbills are all on Appendix I and banned from international trade. The olive ridley is on Appendix II but is banned from trade. The flatback is safe, but is banned from trade because it is easily confused with the green turtle.

This sounds reassuring until one considers: many countries have not signed the treaty; internal commerce is not prohibited; and countries may exempt themselves for reasons of economic hardship or cultural heritage. For example: vast numbers of hawksbill turtles are still killed for import to Japan where they are used in "tortoiseshell" jewelry. The Japanese claim this is a native handcraft and exempt from CITES for cultural reasons. Italy is not a signator and imports olive ridley skins from Mexico for use as leather in expensive shoes and handbags. Even in the United States which strictly adheres to CITES and also has internal protection through the Endangered Species Act, egg poaching occurs. Most countries have no legislation protecting sea turtles from internal trade.

Several ventures in turtle ranching are proceeding. Sea turtles have proven to reproduce poorly in captivity, however, so eggs are frequently taken from wild populations. Also, where any trade in meat is allowed, poaching from wild populations becomes more financially rewarding, because it cannot be distinguished from legal meat.

You can help sea turtles in the southeastern United States in several ways. You may support programs that help with education. You may also lobby parks and seashores to prohibit vehicles on beaches during nesting season from June to September.

If you find sea turtle products for sale or discover a dead or injured sea turtle at the beach, you should contact your regional U.S. Fish and Wildlife office. The Mid-Atlantic regional law enforcement office is 95 Aquahar Rd., Glen Burnie, MD 21061, (301) 761-8033.

Note: The diamondback terrapin, a common resident of Maryland brackish water marshes (salt marshes) is not a sea turtle and is not considered endangered. You may see them for sale in fish markets. Please do not call the USFWS about terrapins.

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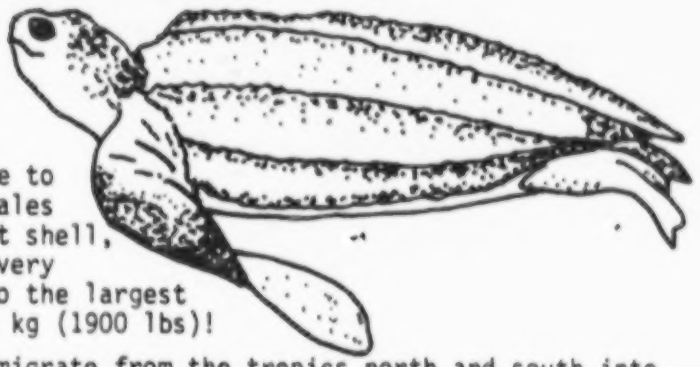
LEATHERBACK



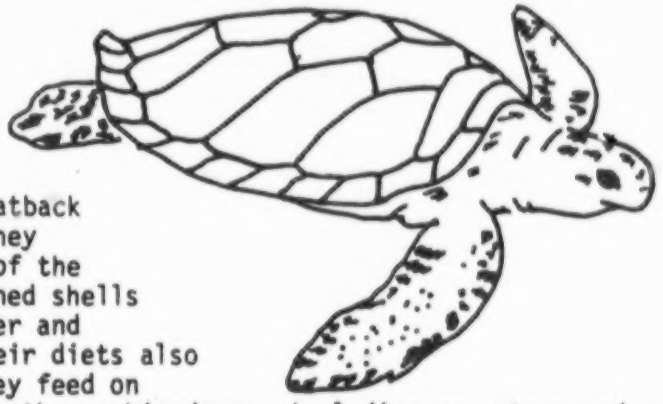
Dermochelys coriacea
worldwide
140cm 300kg black or brown

This is the easiest sea turtle to identify because it has no scales or claws or scutes, has a soft shell, and has 5 long ridges on its very streamlined back. It grows to the largest size with one recorded at 864 kg (1900 lbs)!

These long distance swimmers migrate from the tropics north and south into much colder water. Because of their large mass and high activity levels, they retain heat and are warmblooded! One was recorded with an internal temperature of 27°C (80°F) taken from 7°C (45°F) water. Leatherbacks swim long distances in search of jellyfish, the majority of their diet. They also eat fish and small invertebrates. While they generally are pelagic (live in the open ocean), leatherbacks do come into the Chesapeake Bay during the summer to feed on the abundant jellyfish called stinging nettles. A major cause of death in adult leatherbacks is their mistaken consumption of plastic bags from garbage thrown overboard by ships and boats. Evidently the bags look like jellyfish.

Although found as far north as Canada, they return to nest in the tropics. One leatherback female was tagged while nesting in Trinidad. She was seen there two years later, also nesting. Five years after that she was found dead from eating plastic bags on a beach in New York. Leatherbacks prefer to nest on mainland beaches with deepwater approaches. Beach development and egg removal are serious threats to leatherbacks in addition to ocean garbage dumping.

FLATBACK



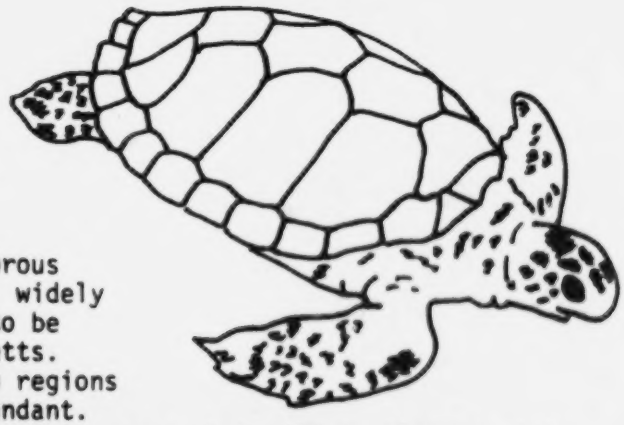
Chelonia depressa
NE coast of Australia
90cm 73kg dark olive gray

As their name implies, the flatback has an oddly shaped shell. They appear to be close relatives of the green turtle, but have flattened shells with a depression in the center and slightly up-turned edges. Their diets also differ from the green's as they feed on sea cucumbers. They will eat other echinoderms, including sea stars and sea urchins.

Flatbacks have been observed out at sea with birds resting on their shell. The theory is that the turtles allow the sea birds to rest there because they warn the turtles of approaching danger when the birds themselves flee.

This is the only sea turtle that is not suffering great decreases in populations. Their meat is distasteful, and they nest on very isolated beaches where there are few predators, human or otherwise. Flatbacks are banned from commercial trade in the U.S. because they are easily confused with the green turtle which is threatened.

GREEN



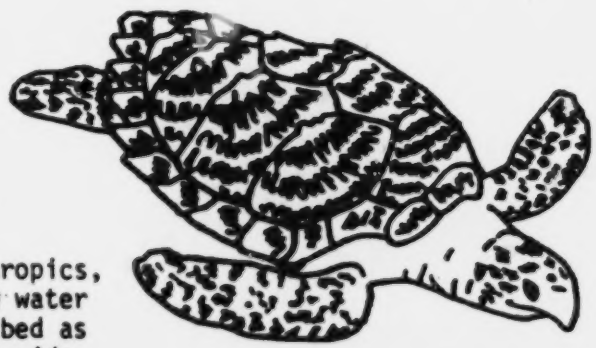
Chelonia mydas
worldwide between 35°N and S
100cm 114kg olive brown above;
pale yellow below

Green turtles are vegetarians as adults, but begin life as carnivorous juveniles. The young may wander widely into temperate regions and used to be common as far north as Massachusetts. The adult range is restricted to regions where sea grass and algae are abundant. Captive greens grow to maturity in 8-10 years, but wild turtles may take 60 years or more to reach sexual maturity.

Generally, greens migrate along coasts from feeding grounds to isolated nesting sites. One population travels from feeding areas along Brazil to nesting beaches on Ascension Island far out in the middle of the Atlantic.

Greens are named for the green color of their fat. They are a very heavily exploited turtle. Their eggs and meat are eaten in many areas. Their scutes are used for jewelry, and their skin made into leather.

HAWKSBILL

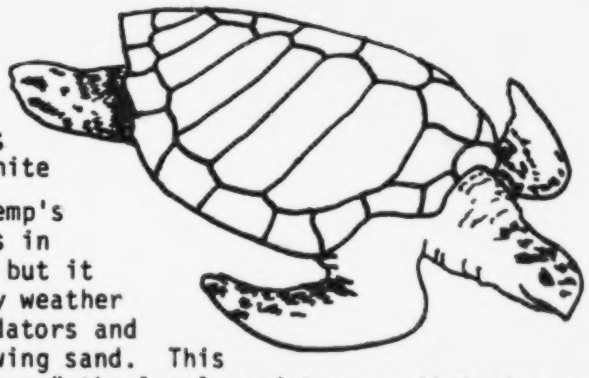


Eretmochelys imbricata
worldwide tropics
80cm 60kg brown with yellow;
yellow below

These small turtles are named for their sharply beaked upper jaw. Hawksbills are restricted to the tropics, living near coral reefs in shallow water along coastlines. They are described as "reef scroungers" since they eat a wide variety of reef organisms, including sea grasses and algae, sponges, sea urchins and other invertebrates, and fish. Their highly patterned shell helps camouflage them against the background of the reef, especially when they wedge into a crack to take a nap. Hawksbills nest singly on island beaches.

Hawksbills have the misfortune to form beautiful "tortoise shell" scutes. They have been killed for centuries because people make jewelry and other decorative items from their scutes. They are also killed and stuffed for tourist sale. In the tropics their eggs are taken for food. Their meat is also eaten even though it is sometimes poisonous from things the hawksbills have eaten. For all these reasons, hawksbills are facing extinction.

OLIVE RIDLEY

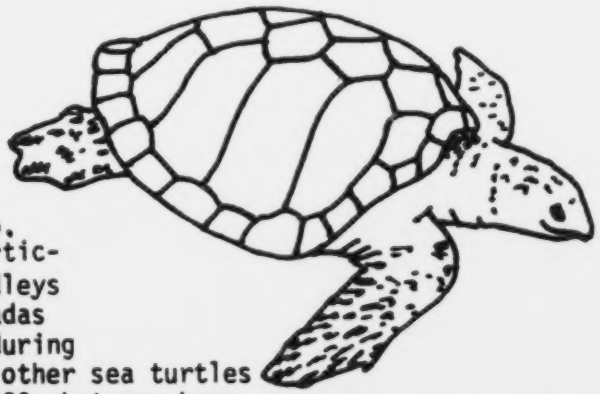


Lepidochelys olivacea
worldwide tropics
72cm 52kg above olive brown;
below yellow or white

Like its close relative the Kemp's ridley, the olive ridley nests in mass groups called arribadas, but it does so at night during stormy weather which discourages natural predators and hides the nest sites with blowing sand. This mass nesting is thought to "swamp" the local predators so that they can not begin to eat all the eggs or hatchlings when they emerge. Humans, however, are not swamped. They take the eggs, eat the adults and sell their skin for leather for luxury shoes and purses.

Olive ridleys eat a wide range of food, including shrimp, jellyfish, crabs, snails, fish, sea grasses and algae. When feeding on bottom-dwelling (benthic) invertebrates, they may dive quite deep. Like the Kemp's ridley, the olive is frequently caught in trawl nets intended to catch fish and other sea food.

KEMP'S RIDLEY

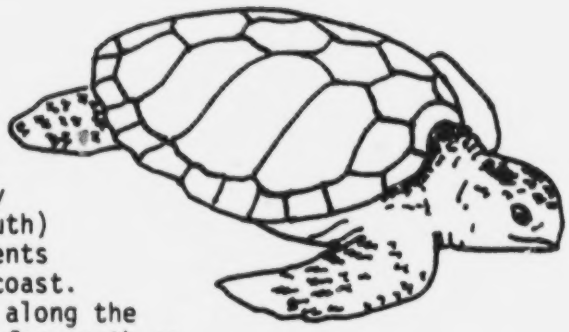


Lepidochelys kempi
Gulf of Mexico
70cm 42kg gray above;yellow
below

These critically endangered turtles nest on only one beach, Rancho Nuevo, in Mexico on the Gulf. They are particularly vulnerable because Kemp's ridleys nest in massive groups called arribadas (from the Spanish word for arrive) during the morning rather than at night as other sea turtles do. These groups once numbered 40,000, but now have only a few hundred. They are killed for meat, and their eggs are taken for human consumption. Domestic animals like dogs and pigs also take the eggs from the nests. Kemp's ridleys are also killed when they are caught in shrimp trawls while feeding on invertebrates in the Gulf.

Because Kemp's ridleys are the rarest of the sea turtles, the United States and Mexico are cooperating to establish a breeding population that nests on protected beaches in Texas where they will not be exploited for food as they are at Rancho Nuevo in Mexico. The baby turtles are imprinted on Texas water and then raised for a year in captivity (called headstarting) before release.

LOGGERHEAD

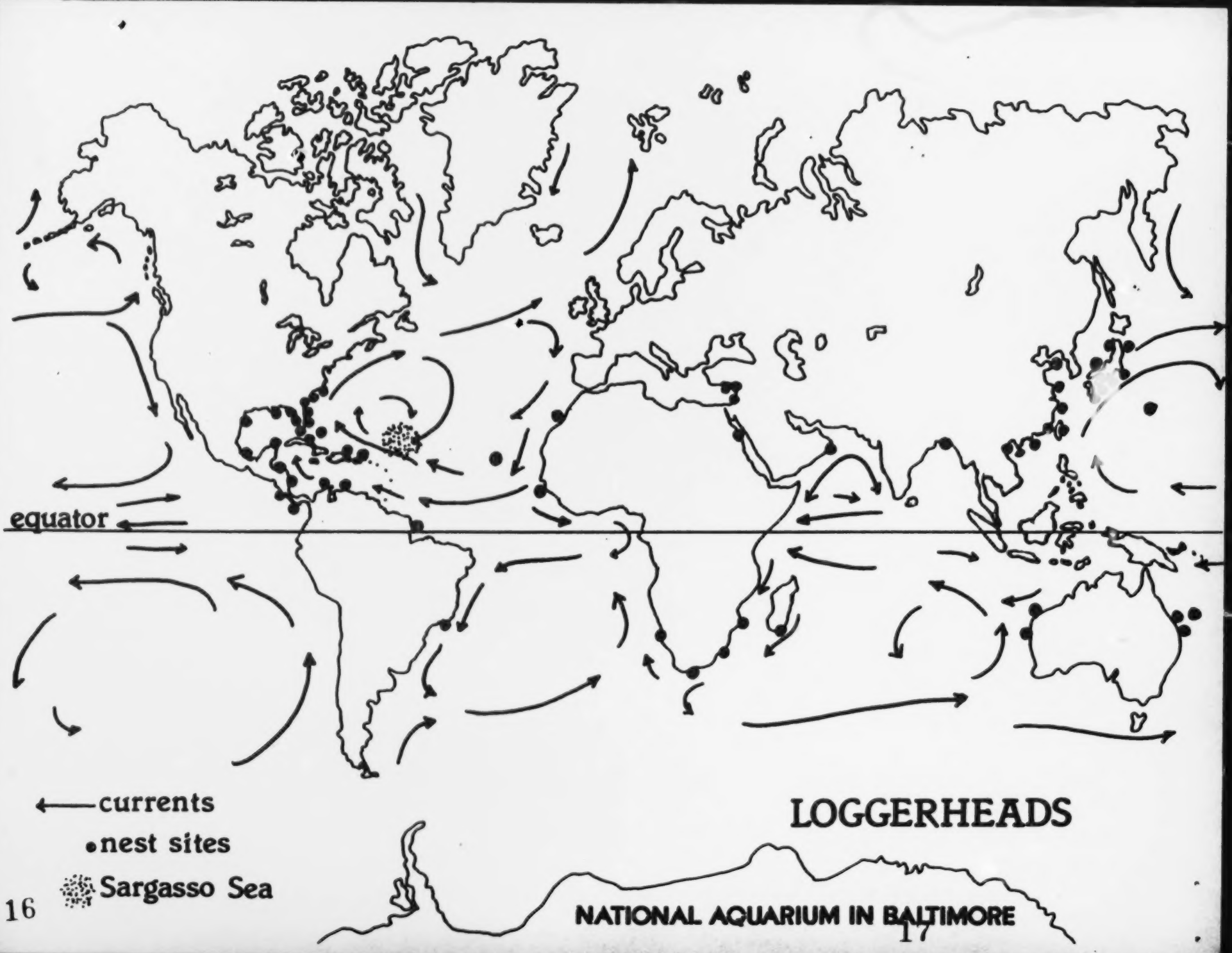


Caretta caretta
worldwide tropics and subtropics
110cm 105kg olive brown to black above; yellow below

While loggerheads nest and live in tropical and subtropical areas, they may range even further north (or south) along the eastern margins of continents where warm currents move along the coast. In summer loggerheads nest and feed along the Gulf and East Coasts of the U.S. as far north as New Jersey. They retreat south in winter. Loggerheads enter brackish water and are frequently spotted by boaters in the lower Chesapeake Bay.

Loggerheads get their name from their particularly large heads which may resemble floating logs when they are resting at the surface. The broad head and powerful jaws are an adaptation for crushing the hard shells of molluscs and crustaceans which form the bulk of their diet. Occasionally, they may also eat sponges, jellyfish, fish, sea grasses and algae. As with other turtles that eat crustaceans, loggerheads are frequently caught and killed in shrimp trawls and other fishing nets. They are also killed by dredges while spending the coldest months of winter buried in the mud hibernating in subtropical regions.

Loggerhead eggs are eaten in most areas where they nest. In the U.S. the greatest threats to loggerheads come from real estate development along coastlines. Nesting beaches disappear under houses and hotels, four-wheel drive vehicles damage nests and leave tracks that hatchlings find impossible to cross, people disturb nesting turtles out of curiosity, and the lights confuse the hatchlings into heading inland rather than out to sea. Programs aimed at solving these problems through public education are sponsored in several states.


equator
currents
nest sites
Sargasso Sea
LOGGERHEADS
NATIONAL AQUARIUM IN BALTIMORE

SEA TURTLE SKELETON OBSERVATIONS NAME:_____

DURING YOUR VISIT, BE ON THE LOOKOUT FOR A SEA TURTLE SKELETON SUSPENDED FROM THE CEILING OF THE BUILDING. IT IS NEAR TWO OTHER SKELETONS, JUST BEFORE THE MOVING WALKWAY THAT TAKES YOU FROM LEVEL 3 TO LEVEL 4.

1. WHAT KIND OF SEA TURTLE IS THIS? _____

2. WHAT IS THE PURPOSE OF THE TURTLE'S CARAPACE (TOP SHELL)?

_____

3. THE PLASTRON (LOWER SHELL) OF THIS SPECIMEN IS SOMEWHAT BROKEN AND SMALLER THAN NORMAL; THEREFORE, YOU CAN GET A GLIMPSE OF THE STRUCTURE INSIDE. ARE THE VERTEBRAE AND RIBS SEPARATE FROM THE SHELL OR ATTACHED?

_____

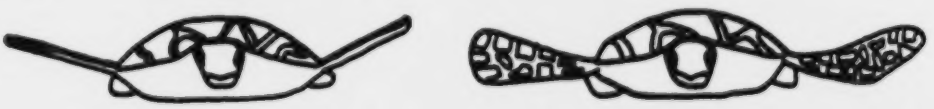
4. NOTICE THE BONES OF THE FLIPPERS. FOR ANIMALS THAT SPEND MOST OF THEIR LIVES IN THE SEA, WHAT ARE TWO ADVANTAGES OF HAVING BONES ENCASED IN TISSUE TO FORM A FLIPPER RATHER THAN INDIVIDUAL TOES?

   A. (HINT: WHICH TYPE OF OAR WOULD PROPEL THIS BOAT MOST EFFICIENTLY?)

   B. (HINT: WHAT DOES THE SKELETON PROVIDE FOR THE MUSCLES?)

5. WHEN SEA TURTLES SWIM WITH THEIR LONG, WING-LIKE FLIPPERS IT SEEMS LIKE THEY ARE FLYING UNDER THE WATER. NOTICE THE ORIENTATION OF THE "WINGS" COMPARED TO THE TURTLE'S SHELL. WHAT IS THE ADVANTAGE OF THIS DESIGN?

   (HINT: IN THE DIAGRAMS BELOW, WHICH SEA TURTLE IS THE STRONGER SWIMMER?)



SEA TURTLE OBSERVATIONS NAME_____

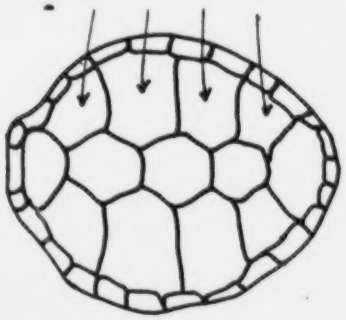
THERE IS A LARGE LIVE SEA TURTLE IN THE ATLANTIC CORAL REEF EXHIBIT (THE FIRST RING TANK). SOMETIMES IT SWIMS ACTIVELY WHILE AT OTHER TIMES THE TURTLE RESTS HIDDEN AMONG THE "CORALS". YOUR FIRST TASK IS TO FIND IT. IF YOU SEE AN EXHIBIT GUIDE, SHE/HE MAY HELP.

A. THE TURTLE IS: ▱ RESTING ON THE BOTTOM
▱ SWIMMING AROUND
▱ TAKING FOOD FROM THE DIVER
▱ OTHER_____

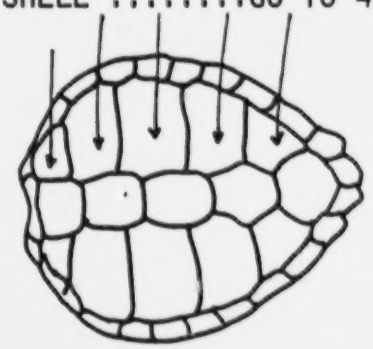
B. TO IDENTIFY THE SPECIES OF THIS TURTLE, MAKE THE FOLLOWING OBSERVATIONS. CHOOSE BETWEEN EACH PAIR OF CHOICES.

1. THE TURTLE HAS ▱ 5 LONG RIDGES ON ITS BACK..LEATHERBACK
▱ HAS SMOOTH PLATES.....GO TO 2

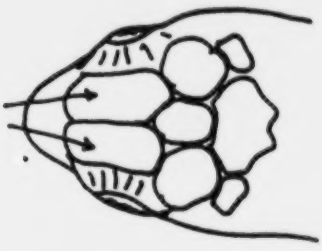
2. ▱ HAS 4 PAIRS OF PLATES ALONG SIDES OF TOP SHELL..... GO TO 3



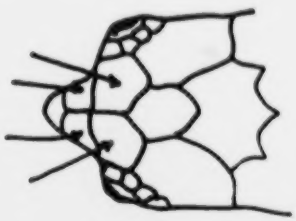
▱ HAS 5 PAIRS OF PLATES ALONG SIDES OF TOP SHELL .....GO TO 4



3. ▱ HAS TWO PLATES BETWEEN ITS EYES.....GREEN



▱ HAS FOUR PLATES BETWEEN ITS EYES.....HAWKSBILL



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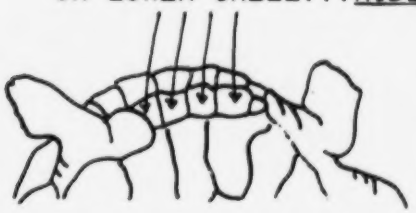
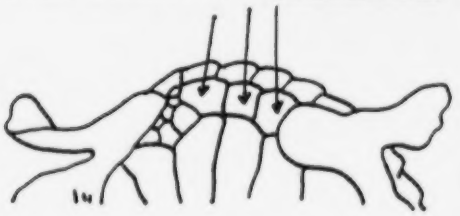
4. ▱ HAS FOUR BRIDGES PLATES ON LOWER SHELL...RIDLEY



▱ HAS THREE BRIDGE PLATES ON LOWER SHELL.....LOGGERHEAD



C. THIS TURTLE IS A _____.

D. DO YOU SEE ANYTHING ABOUT THE WAY THIS TURTLE LOOKS THAT MIGHT LEAD TO THIS COMMON NAME?_____

_____

E. IF THE TURTLE IS SWIMMING, WHICH FLIPPERS PROVIDE THE POWER?
▱ FRONT ▱ REAR

F. HOW LONG DOES THE TURTLE GO BETWEEN BREATHS? IT HAS TO GO TO THE SURFACE FOR AIR TO FILL ITS LUNGS. HOW OFTEN WHEN...
RESTING?_____
SWIMMING?_____
WHICH ACTIVITY USES MORE OXYGEN?_____

G. IF THE TURTLE IS BEING FED BY A DIVER, TRY TO IDENTIFY THE VARIOUS KINDS OF FOOD BEING TAKEN. THEY ARE_____

_____

_____

H. DOES THE TURTLE ▱ CHEW ITS FOOD? ▱ JUST TAKE BITES AND SWALLOW THEM?

I. LOOK CAREFULLY AT THE TURLES SHELL. WATCH WHAT HAPPENS WHEN IT SETTLES DOWN ON THE CORAL "ROCKS". WHY DO YOU THINK IT HAS THE COLOR PATTERNS ON ITS SHELL?_____

_____

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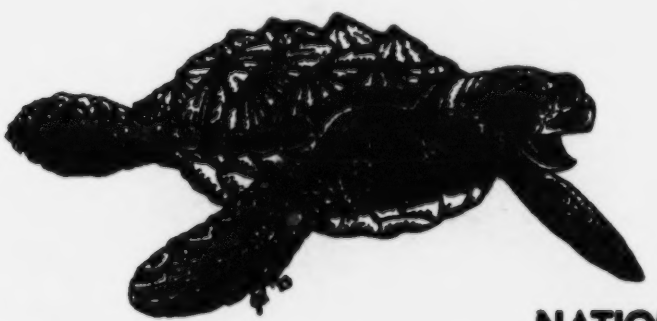
Sea Turtle Vocabulary

Each of these sea turtle words has been scrambled. Can you straighten them out with the help of the clues? If you can, the numbers will give you the letters of the most important sea turtle word of all.

SCRAMBLED WORD	CLUE	UNSCRAMBLED WORD
1. APCERAAC	upper shell	_ 1 _ _ _ _ _ _
2. TUSCES	horny covering over bone of the shell	_ _ _ _ 2 _ _
3. ABKE	in place of teeth	_ 3 _ _
4. LMRAWODODEB	leatherbacks can get up to 80°F, even in cold water	_ _ _ _ _ _ _ _ _ 4 _ _
5. SGEG	baby turtles hatch from them	_ 5 _ _
6. STEN	though they live in the ocean, sea turtles must come to land to do this	6 _ _ _
7. PLFIERPS	swim with these	_ _ _ _ _ 7 _ _
8. SOLT RYEA	the time when baby sea turtles seem to disapper	_ _ _ _ _ _ _ 8
9. RGTMAINOI	traveling between nesting areas and feeding areas	_ _ _ _ _ _ _ _ 9

The most important sea turtle word is:

2	6	4	1	9	5	3	8	7	4



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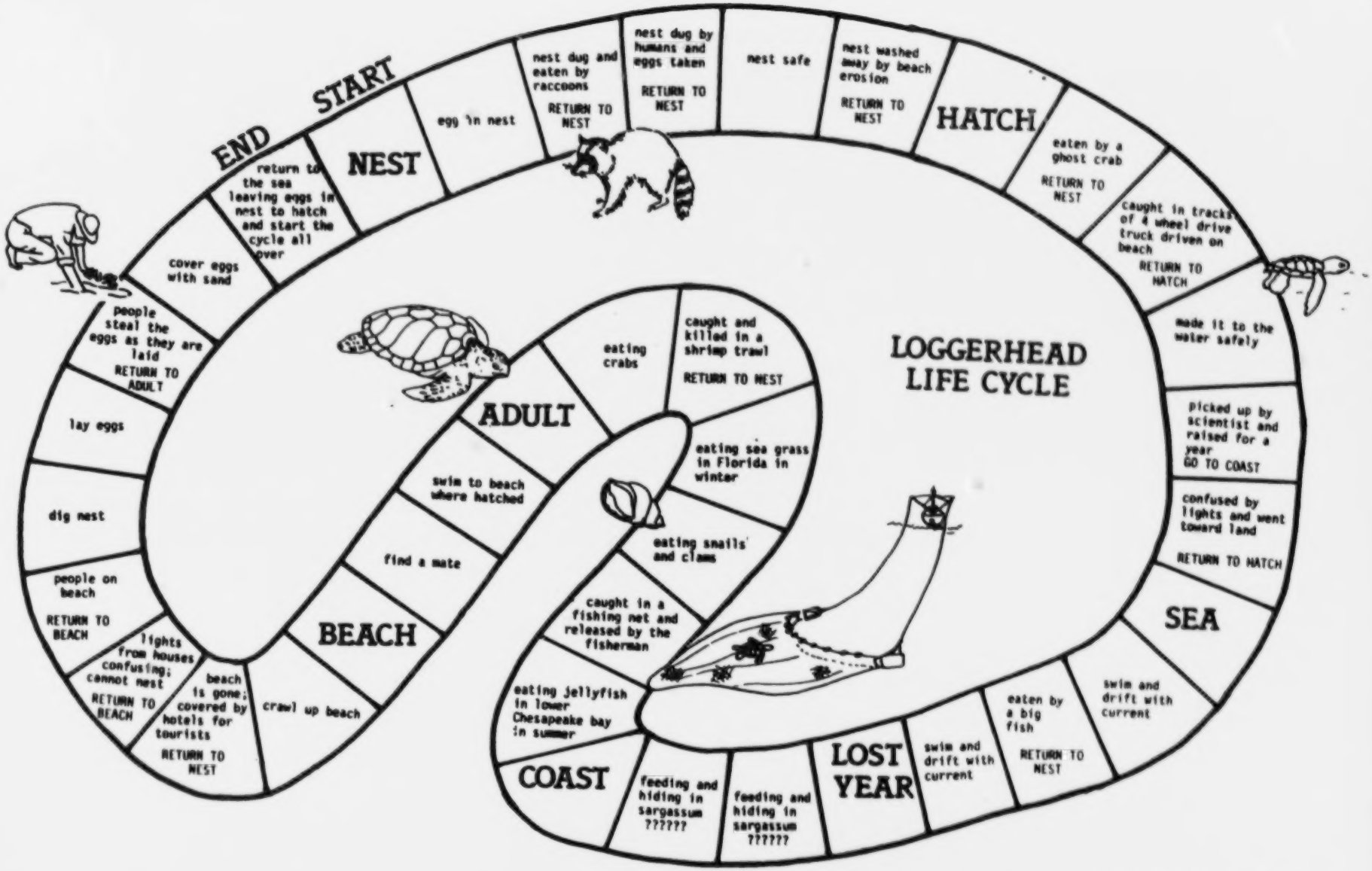

START
END
NEST
egg in nest
nest dug and eaten by raccoons
RETURN TO NEST
nest dug by humans and eggs taken
RETURN TO NEST
nest safe
nest washed away by beach erosion
RETURN TO NEST
HATCH
eaten by a ghost crab
RETURN TO NEST
caught in tracks of 4 wheel drive truck driven on beach
RETURN TO HATCH
made it to the water safely
picked up by scientist and raised for a year
GO TO COAST
confused by lights and went toward land
RETURN TO HATCH
SEA
swim and drift with current
eaten by a big fish
RETURN TO NEST
LOST YEAR
swim and drift with current
feeding and hiding in sargassum ??????
feeding and hiding in sargassum ??????
COAST
eating jellyfish in lower Chesapeake bay in summer
caught in a fishing net and released by the fisherman
eating snails and clams
eating sea grass in Florida in winter
caught and killed in a shrimp trawl
RETURN TO NEST
eating crabs
ADULT
swim to beach where hatched
find a mate
BEACH
crawl up beach
beach is gone; covered by hotels for tourists
RETURN TO NEST
lights from houses confusing; cannot nest
RETURN TO BEACH
people on beach
RETURN TO BEACH
dig nest
lay eggs
people steal the eggs as they are laid
RETURN TO ADULT
cover eggs with sand
return to the sea leaving eggs in nest to hatch and start the cycle all over
LOGGERHEAD LIFE CYCLE

BEST COPY AVAILABLE

TEACHER'S GUIDE TO LOGGERHEAD LIFE CYCLE GAME

This game may be used to introduce a variety of ecological concepts by providing a concrete example of the life history of one species, the loggerhead turtle. The game is a model of the loggerhead life cycle which allows students to collect and analyze data and to draw conclusions from these data.

The class may work as one group, using an enlarged version of the game. You can use an overhead projector to project the game onto a paper covered bulletin board. It can be used as an image or may be traced for a permanent record. You might also reproduce a number of copies of the game for use by small groups which could then pool their data after playing the game.

A die and colored markers are needed. For a bulletin board game, the markers could be colored pins. For use as a board game, colored jellybeans or buttons would do.

GOAL: Starting at NEST, complete one entire circuit of the life cycle going clockwise from NEST without being RETURNED TO NEST. The first player to do this wins. It is not easy.

HOW TO PLAY: Choose turns by rolling the die. High number goes first. Place markers on NEST. Move clockwise the number of spaces indicated by the number rolled on the die for each turn. Read what the space landed upon says and follow the instructions. RETURN TO NEST means you have been killed! You must go back and start over as a new turtle. In other cases RETURN TO just indicates a temporary set back.

When you land on a RETURN TO NEST, make a red spot beside that space to record the fact that a turtle died at that point in the life cycle. The red marks are important.

Sometimes chance results in a quick winner, but more often a player must repeatedly go back and start over. Mortality for sea turtles is very high.

DISCUSSION:
Have students play until a large number of red marks appear on the board. If someone wins early, repeat the game. You are now ready to lead a discussion about their experience. You might proceed by asking them the following questions.

When is the most dangerous time for a loggerhead sea turtle? Why?
The greatest mortality occurs during the development of the egg in the nest and while the hatchlings struggle to reach the sea. The eggs are not protected, just buried. Sea turtles are very awkward on land. The babies have trouble moving. They are also small and have no defense against predators.

How have people contributed to this mortality?
People take the eggs from the nest; introduce predators like rats, pigs and dogs which eat eggs and hatchlings; drive trucks on beaches which make ruts the hatchlings cannot cross; leave their lights on at night which confuses the hatchlings, causing them to head away from the sea.

What human activites have made it hard for turtles to nest?
Beach development, disturbance during nesting, killing nesting turtles for meat, and removal of turtle eggs while being laid all happen. Loggerheads nesting along the southeast U.S. coast generally are safe from human predation but suffer very greatly from human use of beaches for recreation.

How can we graphically display what happens during sea turtles lives with regard to mortality?

Ecologists make survivorship graphs which show the number of individuals in a population at each stage of the life cycle. Add up the total number of red spots plus the number of winners that made it to reproduction. This number represents your total population. Next add up all the numbers of red spots at each stage. For example, mortality in the NEST is represented by the total number of red spots in the first five spaces beyond NEST.

You may use the enclosed form for this or have older students do their own forms. This data sheet will allow you to create a survivorship curve for your turtle population.

How does this curve compare for that of humans? Now? Before medicine?

Students should be able to give a general idea of age-specific mortality. An ecology text should give exact curves. Before medicine infant mortality was as high as 50% by age five.

Insurance premimiums for life insurance are based on survivorship curves for humans.

How do the reproductive strategies of turtles and people differ? How do they spend their energy budget for reproduction?

Sea turtles spend their reproductive energy making large numbers of offspring. One loggerhead female on Sanibel Island, Florida, in 1973 was recorded nesting on six separate occasions and laid a total of 917 eggs that summer. Generally the females nest every second or third year and may make several nests during the summer. Once the eggs are laid, they are on their own. Because there are so many, the odds are that some will survive to grow up and lay more eggs.

Humans require little of their reproductive energy to make fewer offspring than the turtles, but humans spend large amounts of energy feeding and protecting those offspring. Most of them survive to reproduce in modern times. In the past when perhaps 50% of children died before maturity, people compensated by having more children. Both the turtle and human reproductive strategies work. They just spend their energy in different ways.

What was it like to be a sea turtle before people started to have such a major impact on turtle populations?

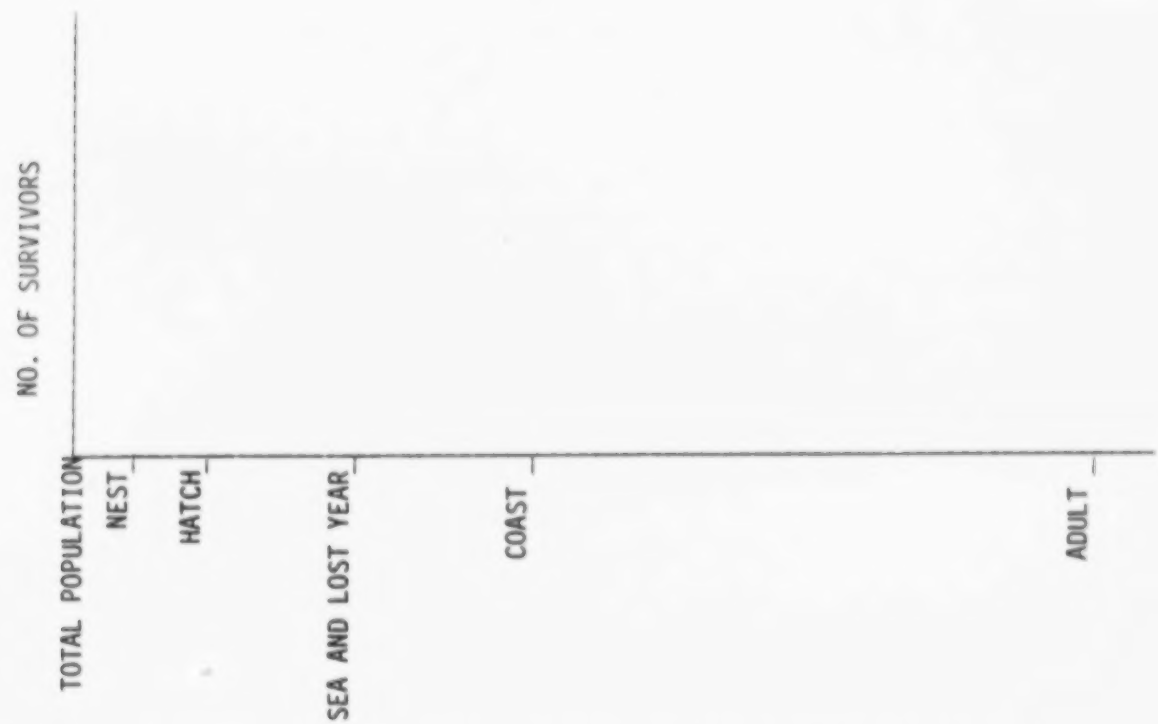
Remove the human influences from the Loggerhead Life Cycle. White out each of the instructions that refers to humans or the consequences of human activities. Because there will be more adult turtles, one instance of mortality should be added to the subadult phase. Change killed in a shrimp trawl to eaten by a shark.

Compare the number of turtles that now survive to reproduce. Under natural conditions the limits to turtle population sizes were probably nest site availability, nest predation, hatchling predation, food availability, and weather.

LOGGERHEAD LIFE CYCLE
DATA SHEET

Name_____

STAGE OF THE LIFE CYCLE	NO. THAT DIED IN THIS STAGE	SURVIVORS (TOTAL MINUS NO. DIED AT THIS STAGE)
NEST		
HATCH		
SEA AND LOST YEAR		
COAST (growing up)		
ADULT AND BEACH		
TOTAL DIED		
NO. OF WINNERS		
TOTAL POPULATION		(and above two numbers)



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SEA TURTLE SKELETON OBSERVATIONS NAME: _____

DURING YOUR VISIT, BE ON THE LOOKOUT FOR A SEA TURTLE SKELETON SUSPENDED FROM THE CEILING OF THE BUILDING. IT IS NEAR TWO OTHER SKELETONS, JUST BEFORE THE MOVING WALKWAY THAT TAKES YOU FROM LEVEL 3 TO LEVEL 4.

1. WHAT KIND OF SEA TURTLE IS THIS? Loggerhead

2. WHAT IS THE PURPOSE OF THE TURTLE'S CARAPACE (TOP SHELL)?
protect internal organs

3. THE PLASTRON (LOWER SHELL) OF THIS SPECIMEN IS SOMEWHAT BROKEN AND SMALLER THAN NORMAL; THEREFORE, YOU CAN GET A GLIMPSE OF THE STRUCTURE INSIDE. ARE THE VERTEBRAE AND RIBS SEPARATE FROM THE SHELL OR ATTACHED?
back bone and ribs are attached to carapace

4. NOTICE THE BONES OF THE FLIPPERS. FOR ANIMALS THAT SPEND MOST OF THEIR LIVES IN THE SEA, WHAT ARE TWO ADVANTAGES OF HAVING BONES ENCASED IN TISSUE TO FORM A FLIPPER RATHER THAN INDIVIDUAL TOES?

A. (HINT: WHICH TYPE OF OAR WOULD PROPEL THIS BOAT MOST EFFICIENTLY?)
Animals with webbed or paddle-like feet use the resistance of the water against the flipper's surface to propel themselves forward.

most surface area

B. (HINT: WHAT DOES THE SKELETON PROVIDE FOR THE MUSCLES?)
The bones provide structure and extra strength for the flipper. They make it stiff. The bones also provide a place for muscles to attach.

5. WHEN SEA TURTLES SWIM WITH THEIR LONG, WING-LIKE FLIPPERS IT SEEMS LIKE THEY ARE FLYING UNDER THE WATER. NOTICE THE ORIENTATION OF THE "WINGS" COMPARED TO THE TURTLE'S SHELL. WHAT IS THE ADVANTAGE OF THIS DESIGN?

(HINT: IN THE DIAGRAMS BELOW, WHICH SEA TURTLE IS THE STRONGER SWIMMER?)

The flippers push back against the water moving the turtle forward.

NATIONAL AQUARIUM IN BALTIMORE.

SEA TURTLE OBSERVATIONS NAME _____

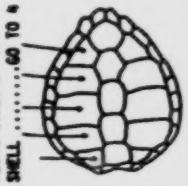
THERE IS A LARGE LIVE SEA TURTLE IN THE ATLANTIC CORAL REEF EXHIBIT (THE FIRST RING TANK). SOMETIMES IT SWIMS ACTIVELY WHILE AT OTHER TIMES THE TURTLE RESTS HIDDEN AMONG THE "CORALS". YOUR FIRST TASK IS TO FIND IT. IF YOU SEE AN EXHIBIT GUIDE, SHE/HE MAY HELP.

A. THE TURTLE IS: ☐ RESTING ON THE BOTTOM
☐ SWIMMING AROUND
☐ TAKING FOOD FROM THE DIVER
☐ OTHER _____

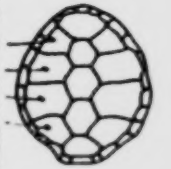
B. TO IDENTIFY THE SPECIES OF THIS TURTLE, MAKE THE FOLLOWING OBSERVATIONS. CHOOSE BETWEEN EACH PAIR OF CHOICES.

1. THE TURTLE HAS ☐ 5 LONG RIDGES ON ITS BACK...LEATHERBACK
☑ HAS SMOOTH PLATES.....GO TO 2

2. ☑ HAS 4 PAIRS OF PLATES ALONG SIDES OF TOP SHELL.....GO TO 3
☐ HAS 5 PAIRS OF PLATES ALONG SIDES OF TOP SHELL.....GO TO 4



3. ☐ HAS TWO PLATES BETWEEN ITS EYES.....GREEN
☑ HAS FOUR PLATES BETWEEN ITS EYES.....HAWKSBILL



4. ☐ HAS FOUR BRIDGES PLATES ON LOWER SHELL...RIDLEY
☐ HAS THREE BRIDGE PLATES ON LOWER SHELL.....LOGGERHEAD

C. THIS TURTLE IS A hawksbill.

D. DO YOU SEE ANYTHING ABOUT THE WAY THIS TURTLE LOOKS THAT MIGHT LEAD TO THIS COMMON NAME? beak looks like beak on hawk

E. IF THE TURTLE IS SWIMMING, WHICH FLIPPERS PROVIDE THE POWER?
☑ FRONT ☐ REAR

F. HOW LONG DOES THE TURTLE GO BETWEEN BREATHS? IT HAS TO GO TO THE SURFACE FOR AIR TO FILL ITS LUNGS. HOW OFTEN WHEN...
RESTING? many stay down for long time - hours!
SWIMMING? every few minutes
WHICH ACTIVITY USES MORE OXYGEN? swimming

G. IF THE TURTLE IS BEING FED BY A DIVER, TRY TO IDENTIFY THE VARIOUS KINDS OF FOOD BEING TAKEN. THEY ARE squid and fish primarily.

H. DOES THE TURTLE ☐ CHEW ITS FOOD? ☑ JUST TAKE BITES AND SWALLOW THEM?

I. LOOK CAREFULLY AT THE TURTLES SHELL. WATCH WHAT HAPPENS WHEN SHE SETTLES DOWN ON THE CORAL "ROCKS". WHY DO YOU THINK SHE HAS THE COLOR PATTERNS ON HER SHELL? camouflage.

NATIONAL AQUARIUM IN BALTIMORE.